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PERFORMANCE ORIENTED PACKAGING TESTING
OF
POLYSTYRENE FOAM CONTAINER
FOR
MK 58 MARINE LOCATION MARKER

BY:

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Performing Activity:
Naval Weapons Support Center Crane
Crane, Indiana 47522-5000

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FINAL

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) Qualification tests were performed to determine whether the polystyrene foam container, for MK 58 Marine Location Markers meets the Performance Oriented Packaging (POP) requirements specified by the United Nations Recommendations on the Transportation of Dangerous Goods. The container loaded to a gross weight of 28 pounds successfully met the requirements and retained its contents throughout the test.					
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INTRODUCTION

The polystyrene foam container designed for shipping and storage of the MK 58 Marine Location Marker was tested to ascertain whether this container would meet the requirements of Performance Oriented Packaging (POP) as specified by the United Nations (UN) Recommendation on the Transportation of Dangerous Goods, Document ST/SG/AC.10/1, Revision 6, Chapters 4 and 9. A Base Level Vibration Test was also conducted in accordance with the rulings specified in the Department of Transportation's (DOT) Performance Oriented Packaging Standards Federal Register/Vol. 55, No. 246/ Friday, December 21, 1990. The objectives were to evaluate the adequacy of the container in protecting the MK 58 Marine Location Marker, as well as to evaluate the container's ability to protect personnel involved with handling and shipping the container.

TESTS PERFORMED

1. Stacking Test

This test was performed in accordance with ST/SG/AC.10/1, Chapter 9, Paragraph 9.7.6. Four different containers were used, and subjected to a stack weight of 1,200 pounds on each container. To ensure that the container, rather than the Marine Location Marker, would sustain the load, empty containers were used for the test. An initial test was performed on two of the empty containers for a period of 24 hours. The container was measured and examined before and after the test and found to be capable of supporting the simulated load of like containers stacked 24 feet high. There was no deformation or compression of the container. A second series of tests was then performed on two additional empty containers for a period of 96 hours. After the allowed time, the weight was removed and the containers examined. Any deterioration, or distortion which could adversely affect transport, reduce strength or cause instability in stacks of packages, was considered cause for rejection.

2. Drop Test

This test was performed in accordance with ST/SG/AC.10/1 Chapter 9, Paragraph 9.7.3. Each container was used for the four flat drops and/or one corner drop instead of the required five containers (one for each drop). The drops were performed from a height of 4 feet in the following sequence:

- a. Flat Bottom
- b. Flat Top
- c. Flat on Long Side
- d. Flat on Short Side
- e. One Corner

This test was performed at ambient, +70 + 20°F temperature. The contents of the container should be retained within its packaging and exhibit no damage liable to affect safety during transport.

3. Base Level Vibration Test

This test was performed in accordance with Appendix C of Part 173, of Federal Register/Vol. 55, No. 246/Friday, December 21, 1990/ Final Rule. Three sample containers were loaded with inert MK 58 Marine Location Markers to a gross weight of 28 pounds and closed for shipment. The three containers were placed on a vibrating platform that had a vertical amplitude (peak-to-peak displacement) of one inch. The containers were not restrained during vibration except by a fence attached to the test surface to prevent them from falling off the table. The containers were tested for 60 minutes in their normal shipping position. The vibratory input to the container was at a frequency that caused the container to be raised from the vibrating platform to such a degree that a piece of material of approximately 1/16" (1.6mm) thickness could be passed between the bottom of the container and the platform.

PASS/FAIL (UN CRITERIA)

The criteria for passing the stacking test is outlined in Paragraph 9.7.6.3 of ST/SG/AC.10/1 and states the following: "No test sample should show any deterioration which could adversely affect transport safety or any distortion liable to reduce its strength or cause instability in stacks of packages".

The criteria for passing the drop test is outlined in Paragraph 9.7.3.5 of ST/SG/AC.10/1 and states the following: "Where a packaging for solids undergoes a drop test and its upper face strikes the target, the test sample passes the test if the entire contents are retained by an inner packaging or inner receptacle (e.g., a plastic bag), even if the closure is no longer sift-proof".

PASS/FAIL (49 CFR CRITERIA)

The criteria for passing the Base Level Vibration Test is outlined in Appendix C of Part 173, Performance Oriented Packaging Standards, Federal Register/Vol. 55, No. 246/Friday, December 21, 1990/Final Rule and states the following: "Immediately following the period of vibration, each package shall be removed from the platform, turned on its side and observed for any evidence of leakage. Rupture or leakage from any of the packages constitutes failure of the test".



by _____	
Distribution/	
Availability Codes	
Bist	Avail and/or Special
A-1	

TEST RESULTS

1. Stacking Test

Satisfactory.

2. Drop Test

Satisfactory during the flat drops, but needed an additional strip of filament tape in the longitudinal direction to pass the corner drop.

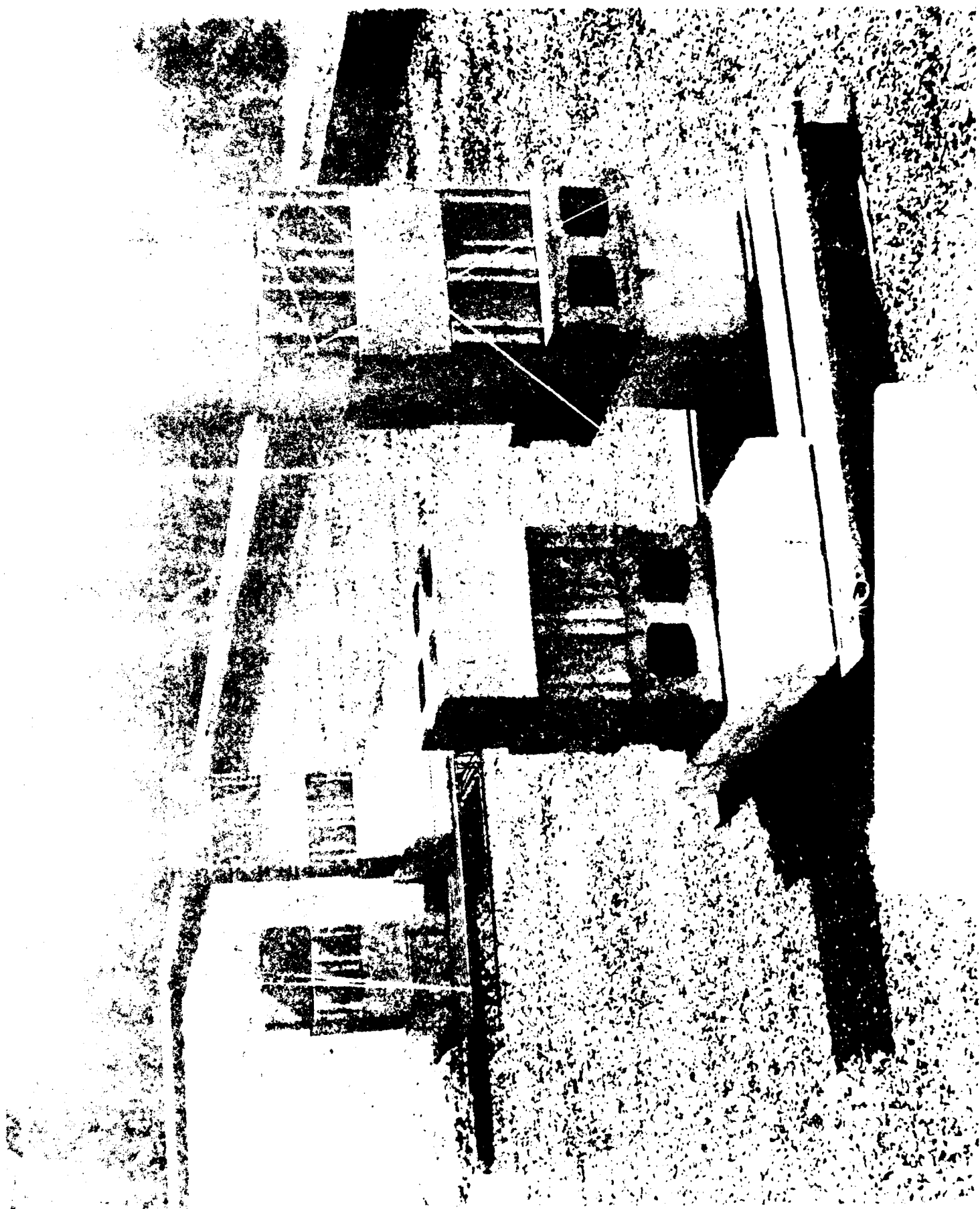
3. Base Level Vibration Test

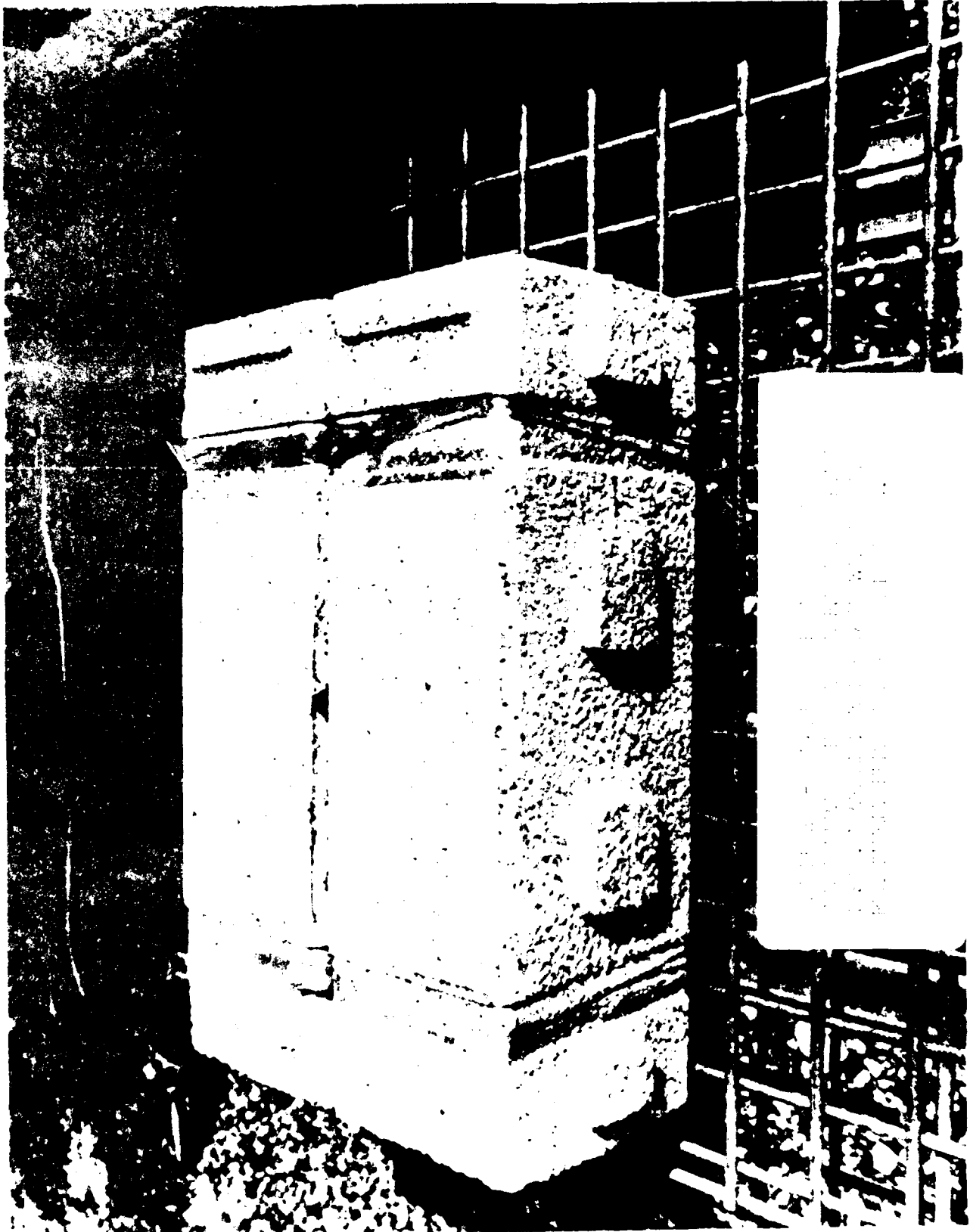
Satisfactory with no leakage.

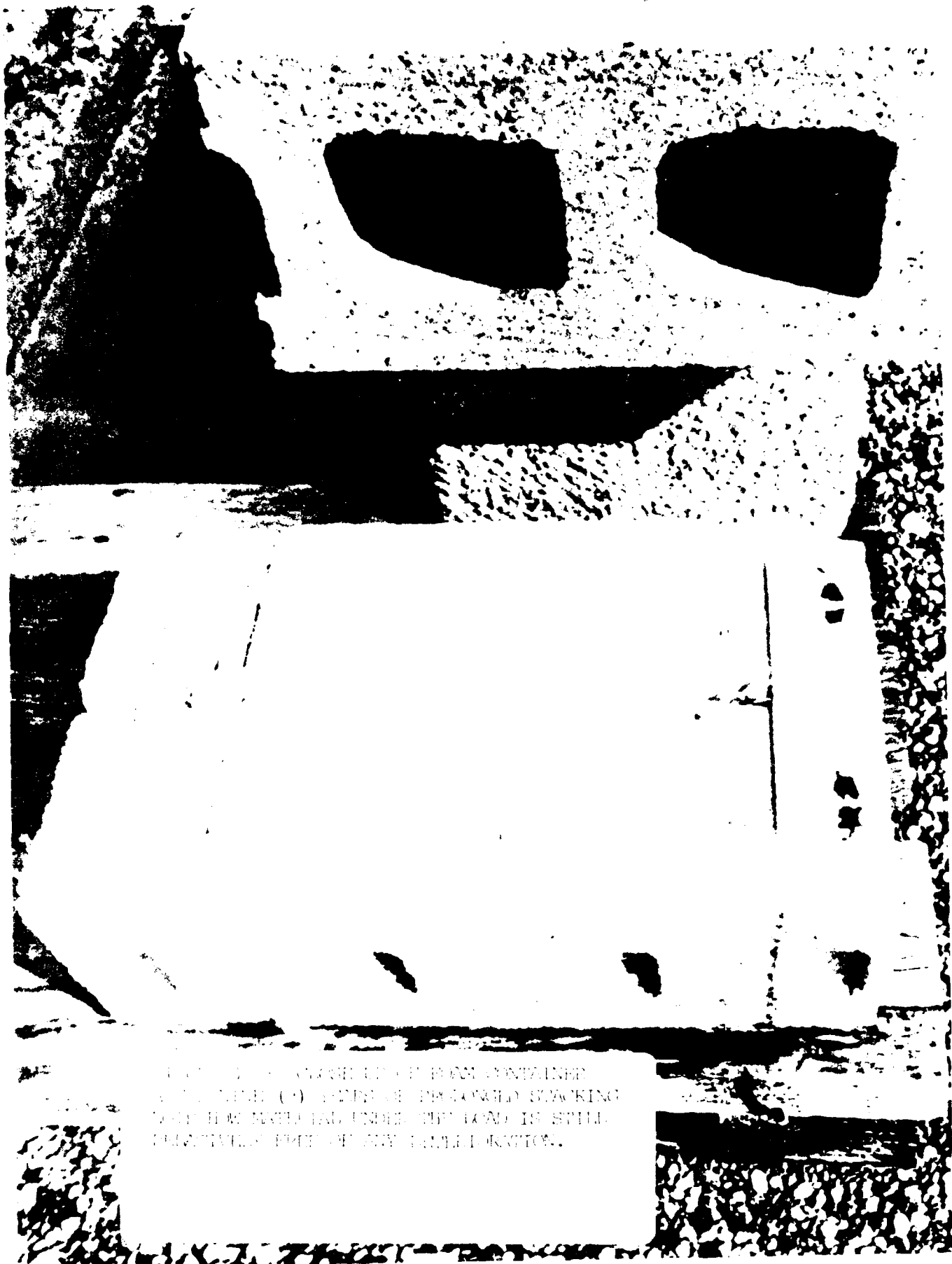
DISCUSSION

1. Stacking Test

Four different containers were used, and subjected to a stack weight of 1,200 pounds on each container. To ensure the container, rather than the Marine Location Marker, would sustain the load empty containers were used for the test. An initial test was performed on two of the empty containers for a period of 24 hours. The container was measured and examined before and after the test and found capable of supporting the simulated load of like containers stacked 24 feet high. There was no deformation or compression of the container. A second series of tests was then performed on two additional empty containers for a period of 96 hours. After the allowed time, the weight was removed and the containers examined. There was no leakage, distortion, crushing, or deterioration to any of the containers as a result of this test. In reviewing historical data on stack tests performed on this container, Naval Ammunition Depot (NAD), Crane, Indiana, RDTR No. 47 titled "Report on Development and Evaluation of MK 58 Marker Container" dated 4 November 1964, stated that this container withstood simulated loading to a height of 30 feet of like containers without damage. In September 1964, a stacking test was also conducted on various other polystyrene foam containers developed by NAD Crane. Each container was loaded to the equivalent concentrated load simulating a stack 15 feet high varying from 2.0 pounds/square inch (psi) to 3.5 psi. The original test containers and configuration are shown in Figure 1. A close up of one container with the load removed after five years is shown in Figure 2. The same box with the load removed after 9 years is shown in Figure 3. As evidenced by these photographs, there was little, if any, compression of the foam containers. Examination of Figure 3, clearly indicates the severity of deterioration of exposed surfaces from light and atmospheric agents exceeded any slight compressive set over the 9 year test period.







THE OBJECT IS A LARGE, DIRT-CONTAINING
CONTAINER (A) WHICH IS PROBABLY BEING
USED FOR DISPOSAL OF WASTE. THE OBJECT IS STILL
INITIALLY FREE OF ANY HAZARDOUS WASTE.

2. Drop Test

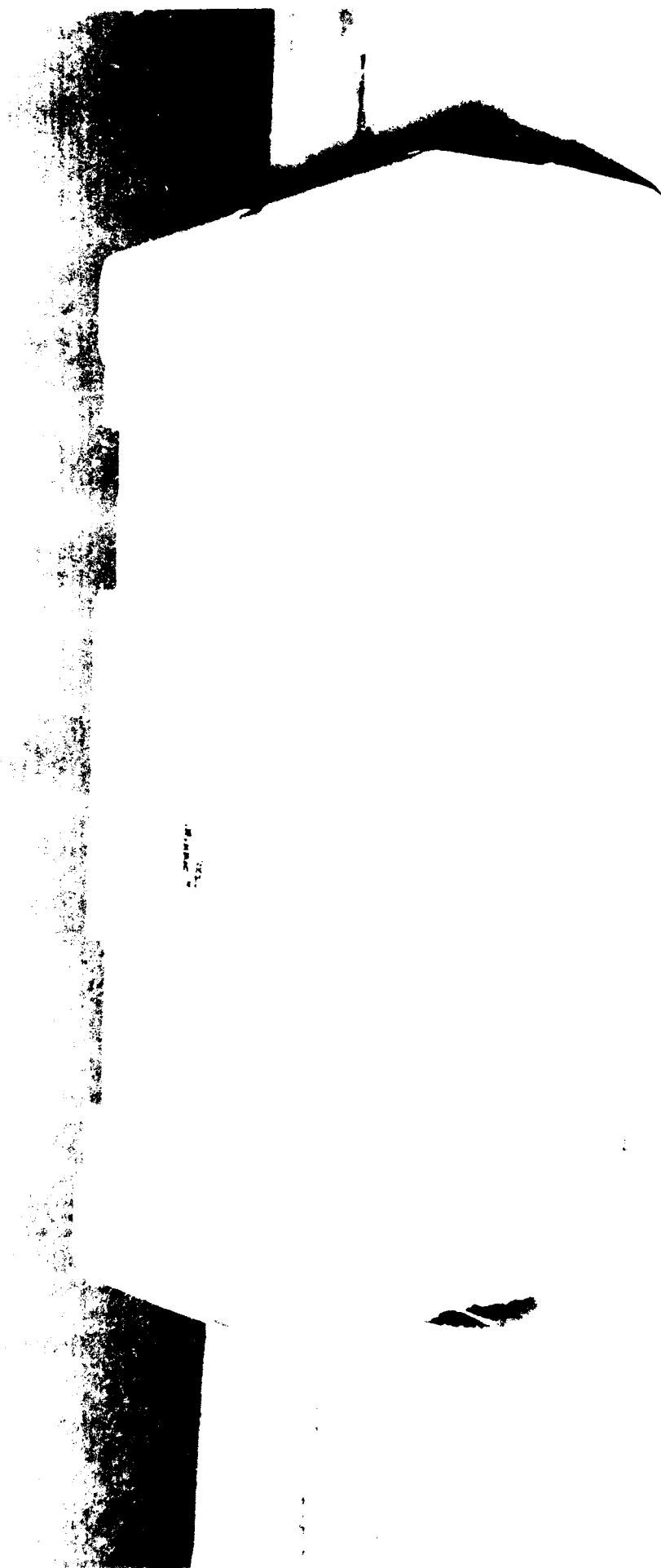
Container number 1, was subjected to a flat drop on the bottom and inspected for any damage which would be a cause for rejection. Since there was no evidence of damage, the same container was subjected to three additional flat drops on the top, long side and the short side without damage. The container was then subjected to a corner drop from a height of four feet. Upon impact, the opposite corner on the same end of the container failed and the Location Marker was exposed as shown in Figure 4. Containers number 2 and 3, were tested and found to also pass the flat drops but failed the corner drop. The container was then modified by substituting 2 strips of 1" wide glass reinforced tape for the strip centered on the long side. The two strips of tape were 3.5 inches from either outer edge. Container number 4, dropped flat on it's top, and then on a corner from a height of 48 inches, suffered only compression on the corner tested with no major fractures, see Figure 5. Container number 5, was subjected to a corner drop also, and showed no evidence of container fracture, as shown in Figure 6, and only minor compression on the interior of the container. Final inspection indicated damage was minimal with only minor deformation noted, particularly after the corner drop. The container remained intact and serviceable on completion of the tests, see Figures 5 and 6.

3. Base Level Vibration Test

Immediately after the vibration test was completed, each container was removed from the platform, turned on its side and observed for any evidence of leakage. The tape remained intact, the seals were not broken, and there was no evidence of leakage or damage to the contents.

4. General

Although many discussions have been held over the past 27 years concerning the use of polystyrene containers for ordnance and pyrotechnic packaging, there are no known records available indicating that the container has not done its job in protecting the item. The tensile test associated with the MK 58 Marine Location Marker design, (see RDTR-47 in references) has forced the manufacturers to maintain quality in their molding procedure and the container itself has allowed the Navy to come as close to the ideal package as possible. That is, a container that weighs nothing, costs nothing and takes up no space. The price of the MK 58 Marine Location Marker container has risen from \$1.14 each in 1966, to approximately \$10.00 each in 1991, but it still represents less than 3.6 percent of the cost of the item. The 1.7 pounds it adds to the weight of the two items is also less than seven percent of the overall weight. It does constitute 63 percent of the overall cube, but even this is less than most wood and metal containers would require.



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SAFE

1374 07 07 051 138
MK 58 400 1
MK 58

4 4
47 25 185 05 17 15
137 07 07 051 138

FIGURE 5 - MK 58 MARINE LOCATION MARKER
FOUNDSWERE FROM CONTAINER AFTER ONE
FLYING DROP AND ONE CORRECTION DROP FROM A
HEIGHT OF FOUR (4) FEET AFTER TWO SUPPLIES
OF TAPES WERE USED TO SHAKE THE CONTAINER
IN THE LONGITUDINAL DIRECTION

REFERENCE MATERIAL

United Nations "Recommendation on the Transportation of Dangerous Goods", ST/SG/AC.10/1, Revision 6

49 CFR Part 107, et al. Performance-Oriented Packaging Standards, Federal Register/Vol. 55, No. 246/Friday, December 21, 1990, Final Rule

Research and Development Department, RDTR-47, Report on Development and Evaluation of MK 58 Marker Container, 4 November 1964, U. S. Naval Ammunition Depot, Crane, Indiana

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DATA SHEET

Container: Polystyrene Foam Shipping and Storage Container For the MK 58 Marine Location Marker	
Type: 4H1	UN Code: 1.3G
Specification Number: MIL-P-19644	Material: Polystyrene Foam
Capacity: 13 kg (28 pounds)	Dimensions: .64 m (L) x .36 m (W) x .17 m(H) (25.25" L x 14.25" W x 6.50" H)
Closure (Method/type): Glass filament Reinforced Tape	Tare Weight: 10.67 kg (26.3 pounds)
Additional Description: SHIPPING AND STORAGE CONTAINER, consisting of identical container halves, Drawing 2141466	
<p>-----</p> <p>PRODUCTS:</p> <p>MK 58 MOD 0 Marine Location Marker, L585, 1370-00-794-4594</p> <p>MK 58 MOD 1 Marine Location Marker, L580, 1370-01-074-0591</p> <p>Proper Shipping Name: MK 58 MOD 0-Cartridges, Signal MK 58 MOD 1-Fireworks</p>	
<p>United Nations Number: MK 58 MOD 0 - 0054 MK 58 MOD 1 - 0335</p>	
United Nations Packing Group: II	
Physical State: Solid	
Amount Per Container: Two (2)	
Net Weight (MK 58 Marker): 5.45 kg (12 pounds)	
<p>-----</p> <p>TEST PRODUCT:</p>	
Name: Inert MK 58 Marine Location Markers	
Physical State: Solid	
Size : .12 m Dia x .55 m L	
Quantity : Two (2)	
Dunnage: None	
Gross Weight: 13 kg (28 pounds)	

SUPPLEMENTARY

INFORMATION

ERRATA

2 December 1991

TEST DATA SHEET

Container: Polystyrene Foam Shipping and Storage Container For the MK 58 Marine Location Marker

Type: 4H1	UN Code: 1.3G
Specification Number: MIL-P-19644	Material: Polystyrene Foam
Gross Weight: 13 kg (28 pounds)	Dimensions: .64 m (L) x .36 m (W) x .17 m(H) (25.25" L x 14.25" W x 6.50" H)
Closure (Method/type): Glass filament Reinforced Tape	Tare Weight: 1.6 kg (3.5 pounds)

Additional Description: SHIPPING AND STORAGE CONTAINER, consisting of identical container halves, Drawing 2141466

PRODUCTS:

MK 58 MOD 0 Marine Location Marker, L585, 1370-00-794-4594

MK 58 MOD 1 Marine Location Marker, L580, 1370-01-074-0591

Proper Shipping Name: MK 58 MOD 0 Cartridges, Signal
MK 58 MOD 1 Fireworks

United Nations Number: MK 58 MOD 0 - 0054
MK 58 MOD 1 - 0335

United Nations Packing Group: II

Physical State: Solid

Amount Per Container: Two (2)

Net Weight (MK 58 Marker): 10.9 kg (24 pounds)

TEST PRODUCT:

Name: Inert MK 58 Marine Location Markers

Size: .12 m Dia x .55 m L

Physical State: Solid

Quantity : Two (2)

Dunnage: None

Gross Weight: 13 kg (28 pounds)

*disregard data sheet that is not an
ERRATA*

AOA 236996